8-6 The student will demonstrate an understanding of the properties and behaviors of waves. (Physical Science)

Key Concepts
Waves: matter vs. energy, mechanical vs. electromagnetic
Wave properties: frequency, amplitude, wavelength, speed
Wave behaviors: refraction, reflection, transmission, and absorption
Hearing: sound waves, ear structure
Sight: eye structure, light waves emitted or reflected
Color: absorption and reflection of light waves
Electromagnetic spectrum: wave energy, wavelengths, visible light, infrared & ultraviolet radiation

Supporting Content Web Sites

University of Illinois: Weather World 2010 Project
http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/opt/home.rxml
Light and Optics section. Photographs and graphics are used to explain meteorological optical phenomena caused by the reflection, scattering, refraction, and diffraction of the suns rays through water droplets, particulates, and ice crystals.
8-6.3, 8-6.4, 8-6.8

Oregon Museum of Science and Technology: Dangerous Decibels
http://www.dangerousdecibels.org/virtualexhibit.cfm#
A virtual tour that includes interactive models of the propagation of a sound wave, the movement of a sound wave through the human ear, variations in sound frequency, and the measurement of the intensity of everyday sounds.
8-6.3, 8-6.5

Nova Online: Voyage to the Mystery Moon
http://www.pbs.org/wgbh/nova/titan/sounds.html
Cassini-Huygens researcher Bruce Betts explains how sounds were used to collect data about Titan. The interactive site begins with an explanation of how sound is transmitted on Earth and how humans perceive sound, then provides a sample of two sounds that were recorded by the Huygens probe with an accompanying explanation of what those sounds revealed about Titan.
8-6.1, 8-6.2, 8-6.5

Nova Online: Wave That Shook the World Anatomy of a Tsunami
http://www.pbs.org/wgbh/nova/tsunami/anatomy.html
Interactive overview of the 2004 Indian Ocean tsunami that includes an animation and explanation of the propagation of the seismic wave including the effect of the ocean's depth at various locations on the wavelength, amplitude, and speed of the wave.
8-6.1, 8-6.2, 8-6.3

Nova Online: Death Star A Self-Guided Tour of the Electromagnetic Spectrum
http://www.pbs.org/wgbh/nova/gamma/spectrum.html
Moving the cursor across the electromagnetic spectrum reveals the characteristics of each range and the technological applications of each. The interactive site also relates the connection of each section of the electromagnetic spectrum to the exploration of space.
8-6.1, 8-6.2, 8-6.8

Amazing Space Catch the Waves and Making Waves
http://amazing-space.stsci.edu/resources/explorations/light/CatchWaves_activation-frames.html
Site includes an interactive prism, generation of a water wave, comparison of ranges of the electromagnetic spectrum to similar sized objects, comparison of views of the Sun as seen through different wavelengths of light, and a summary of concepts that have been explained. Making Waves allows students to manipulate the wavelength and frequency of a "rope" wave.
8-6.3, 8-6.8

An Interactive Diagram of the Human Eye
http://www.nei.nih.gov/health/eyediagram/index.asp
Slide the hand lens across the diagram to magnify each of the major parts of the eye. Click on the target symbols to read a description of the function of each part.
8-6.6

Fear of Physics: What is Sound?
http://www.fearofphysics.com/Sound/dist.html
Animation and explanation of the movement of air molecules during the propagation of a sound wave. The final frame shows how the air molecules interact with a human ear, and then provides a link to sounds of various frequencies and an explanation of the universal frequencies used on touch tone phones.

Comparison of Wavelength and Frequency
http://www.acoustics.salford.ac.uk/schools/lesson1/flash/wavelength.swf
A series of four interactive slides that illustrate the generation of waves of different wavelength. A comparison is then made between the wavelengths of the waves and their frequencies.
8-6.3

Colors of Light
http://www.mic-d.com/java/additiveprimaries/index.html
Tutorial allows students to manipulate disks of "light" in primary colors to illustrate the relationship between colors, white light, and the mixing of wavelengths of light to produce other colors. Also provides accompanying text that explains the relationship between light and the perception of color.
8-6.7

Suggested Literature

Isaacs, A. (2005). *Characteristics and behaviors of waves: understanding sound and electromagnetic waves.* New York: Rosen Publishing Group.
ISBN: 1404203311
Lexile: not available
Describes the parts, behavior, and properties of waves and gives definitions of terms related to waves. Also includes descriptions of the occurrence of waves in real world situations.
8-6.2, 8-6.3, 8-6.4, 8-6.8

Parker, S. (2005). *Making waves: sound*. Portsmouth, NH: Heinemann Library.
ISBN: 1403448140
Lexile: not available
Discusses how sound waves are formed and the properties of sound waves including pitch, volume, and speed. Also includes information about how humans and other animals perceive sound and how sound is generated and managed in technological applications.
8-6.3, 8-6.5

Stille, D. (2006). *Waves: energy on the move.* Mankato, MN: Compass Point Books.
ISBN: 075651259X
Lexile: not available
Colorful diagrams illustrate the structure of water, sound, light, radio, and seismic waves.
8-6.1, 8-6.2, 8-6.5, 8-6.6

Parker, S. (2001). *Light and sound***. Austin, TX: Raintree Steck-Vaughn.**
ISBN: 0739810111
Lexile: not available
Extensive use of figures, charts, diagrams, and photographs to describe the nature of light and sound. Includes a discussion of color and brightness, ears and hearing, and sound and light phenomena such as echoes, sonar, lasers, and holograms.
8-6.2, 8-6.5, 8-6.6, 8-6.7

Ball, J. (Ed.). (2003). *Sound.* New York: G. Stevens for the Discovery Channel.
ISBN: 0836833635
Lexile: not available
Information and activities related to the principles of sound, animal and human hearing, sound applications in medicine and noise pollution.
8-6.5

Burnie, D. (2000). *Light.* NewYork: Dorling Kindersley.
ISBN: 0789467097
Lexile: 1000
The familiar Eyewitness format includes numerous color photographs with extensive captions to illustrate the wave properties of light, the phenomenon of color, refraction and reflection, and the principles of optics.
8-6.4, 8-6.6, 8-6.7, 8-6.8

Silverstein, A. (2001). *Hearing.* Breckingridge, CO: Twenty-First Century Books.
ISBN: 0761316663
Lexile: not available
Explains hearing from the mechanics of the sound wave to the perception of sounds in the human brain. Includes labeled diagrams of the human ear and discusses technology that has been developed to assist the hearing impaired.
8-6.5

Gardner, R. (2004). *Light, sound, and waves science fair projects: using sunglasses, guitars, CDs, and other stuff.* Berkeley Heights, NJ: Enslow Publishers.
ISBN: 0766021262
Lexile: not available
This is not your ordinary science fair fare. The novelty of the materials used will provide an engaging experience for students as they investigate the principles of sound, color, vision, refraction, and reflection.
8-6.4, 8-6.5, 8-6.6, 8-6.7

Stille, D. (2006). *Manipulating light: reflection, refraction, and absorption.* Mankato, MN: Compass Point Books.
ISBN: 0756512581
Lexile: not available
High interest, lower reading level introduction to reflection, refraction, and absorption that includes explanations of how mirrors, prisms, and telescopes work.
8-6.4

Skurzynski, G. (2005). *Waves: the electromagnetic universe.* Washington, DC: National Geographic.
ISBN: 0792235207
Lexile: not available
Color photographs and easily understood diagrams provide information about the ranges of wavelengths in the electromagnetic spectrum and the modern technologies that are derived from them.
8-6.7, 8-6.8

Suggested Streamline Video Resources

Breaking the Silence: An Introduction to Sound
Segment 3: Energy and Sound: Loudness and Frequency (3:33)
Segment 4: What is Pitch? (2:05)
ETV Streamline SC
Relates the energy of a sound wave to the amplitude of the wave, and then shows how this is different from the frequency of the wave. The segment presents demonstrations that students can easily reproduce to illustrate the concepts.
8-6.3, 8-6.5

Breaking the Silence: An Introduction to Sound
Segment 8: Energy and Sound: How Do Sound Vibrations Reach Our Ears
ETV Streamline SC
This segment includes an animation of the vibration of molecules in air producing a compression wave, as well as an animation of the wave interacting with a human ear.
3:29
8-6.5

Science Investigations Physical Science: Investigating Sound and Light
All About Telescopes
ETV Streamline SC
Begins with a brief history of the development of the microscope then quickly moves to a comparison of refracting and reflecting telescopes. The last part of the segment describes the Hubble Telescope and how its images are transmitted to Earth.
9:20
8-4.10, 8-6.4

Science Investigations Physical Science: Investigating Sound and Light
Echolocation and Dolphins
ETV Streamline SC
Describes how dolphins use echolocation to navigate and find food in dark water. Includes an animation that shows how the sound wave is generated as a vibration by the dolphin and how that wave is reflected off of a distant object.
3:38
8-6.1, 8-6.4

Exploring Light and Color
Segment 3: Light and Color (6:39)
Segment 5: Mirrors and Lenses (3:14)
ETV Streamline SC
Segment begins with an animation of refraction by a prism to produce a visible spectrum and shows the relationship of visible light to the electromagnetic spectrum, while focusing on the ultraviolet and infrared segments found in sunlight. It continues with an explanation of absorption and reflection of light, our perception of color, primary colors of light, and the potential confusion with primary colors in pigments.
8-6.3, 8-6.4, 8-6.6, 8-6.7, 8-6.8

Exploring Light and Color
Segment 2: Light and the Sense of Sight
ETV Streamline SC
Provides a summary of the major structural components of the human eye (pupil, iris, cornea, lens, retina, optic nerve) and the interaction of each part with a reflected light wave. Also provides information about vision in other animals as compared to that of humans.
4:54
8-6.6

Inquiring Minds: From Sky to Sea
Segment 1: Blue Sky
ETV Streamline SC
Uses the concepts of absorption, reflection, refraction, and emission to explain why the sky is blue, sunsets are red, space is black, and why water is clear in a small container, but blue in a large body like the ocean. Provides several animations of the refraction of the wavelengths of visible light by air and water molecules.
5:05
8-6.3, 8-6.4, 8-6.7, 8-6.8

Physical Science: Light
Segment 3: Magic of Sight: How Our Eyes Work
ETV Streamline SC
Excellent diagrams of the parts of the eye and how they function.
2:24
8-6.6

Physical Science: Light
Segment 4: The Electromagnetic Spectrum
ETV Streamline SC
A survey of the segments of the electromagnetic spectrum through an exploration of the universe. The discussion of each range of the spectrum is accompanied by visual images of the universe from telescopes and space probes that gather the wavelengths of light in that range.
3:02
8-6.8, 8-4.10

Career Connections

Acoustical architect
Acoustical architects develop building designs that most efficiently distribute desirable sounds (music, conversation, oral communication) while reducing undesirable sounds (background noise, mechanical noise). This specialized architect would be involved in the design of music halls, theaters, museums, recording studios, and TV/movie sets and would require a deep understanding of transmission, absorption, and reflection of waves.

Acoustical engineer
Acoustical engineers are specialized mechanical engineers who have an equally strong background in electrical engineering. They develop transducers (devices that convert sound energy into another type of energy or vice versa) and sound measuring instruments such as those used in seismic surveying, sound recording, and medical diagnostics.

Audiologist
An audiologist is a licensed medical care provider that examines and provides intervention services for persons with speech and hearing disorders to help them improve their ability to

communicate. They require a thorough understanding of the mechanics of sound waves and the structure and function of the human ear.

Sonographer

Sonographers (ultrasonographers) are medical technicians who specialize in the use of high frequency sound waves to produce dynamic visual images of organs, tissues, or blood flow inside the body. They select equipment settings, use a transducer to collect the image, look for visual cues of an unhealthy image, take measurements, calculate values and analyze results to relay to a physician.

Optometrist

Optometrists examine eyes to diagnose vision problems and diseases, test patients' visual acuity, depth perception, color perception, ability to focus and coordinate the eyes, and prescribe eyeglasses and contact lenses to correct vision problems. An optometrist would require knowledge of the refraction of light through lenses, color perception, and the structure of the human eye.